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Analyse the Therapeutic Properties and Compounds in Medicinal Plants

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ABSTRACT

This comprehensive review aims to provide an in-depth analysis of the therapeutic properties of medicinal plants. The paper begins with an introduction to medicinal plants, providing an overview of their therapeutic properties and their significant role in various traditional healing practices. It then delves into the scientific evidence supporting the therapeutic potential of these plants, highlighting their efficacy in treating a wide range of ailments. Moreover, the review identities key medicinal plants and explores their specific health benefits, shedding light on their potential applications in modern medicine. Lastly, the paper addresses the challenges faced in researching and utilizing medicinal plants and discusses future directions. This review is a valuable resource for researchers, healthcare professionals, and individuals interested in exploring the potential of medicinal plants in promoting health and well-being.

KEYWORDS: *therapeutic, medicinal, plants, significant, health, modern*

INTRODUCTION

Globally, traditional herbal medicines have played a vital role in health systems, and are used to treat various acute and chronic conditions without or minimal toxic effect. Herbal plants are often used as a natural remedy to cure various health problems including tuberculosis, cancer, diabetes mellitus, heart diseases, wound healing, asthma, pharyngitis, hypertension etc. Plants rich in bioactive phytomedicine compounds such as alkaloids, flavonoids, tannins and polyphenols have been used to cure illnesses because of their various pharmacological properties. India is always known to be rich depository of medicinal plants and various forms of herbal medicine practices are considered as "living tradition". However, there is no collective report on the significant Indian medicinal plants and their current progress in medicinal plant research. Hence, the prime focus of this review is to identify and report the majorly used Indian medicinal plants that have grown in India and neighboring countries based on a complete research survey of local and international research articles.[1,2,3] The review mainly summarizes the prominent Indian medicinal plants, their extract and its corresponding pharmacological properties such as anti-microbial, antioxidant, anti-diabetic, and anti-cancer etc. The significance of this review is aimed to provide a detailed and collective scientific evaluation of the key phytocompounds and its pharmacological action for the possible development of new ethnomedicine in the future.

The curative properties of medicinal plants are due to presence of major group of active components which are mainly alkaloids, triterpenoids, essential oils and phenolic compounds etc. Alkaloids are the secondary metabolites of plants having noticeable pharmacological activity. Roots, leaves, bark and seeds are common parts of plants which contain alkaliods. In general the alkaloids occur as salts of citric acid, oxalic acid, acetic acid and tartaric acid. These are mostly colorless, water insoluble and non-polar solvents soluble in nature. Pharmacologically, alkaloids act as cardiac depressants, antihypertensive, anti-leukemic, analgesic, nerve stimulants and local anesthetic. Triterpenoids are made up of six isoprene units. Saponins, sterols and cardiac glycosides are chief triterpenes. The medicinal plants which have saponins are roots of Glycyrrhiza glabra, tuberous roots of Asparagus racemosus and roots of Smilax glabra. Typically sterols are animal substances but recently detected from plants also. Ergosterol, stigmasterol, campesterol and β-sitosterol are chief sterols derived from plants. In several plants characteristic odor is due to presence of essential oils or volatile oils which occur in lysigenous or schizogenous cavities, in glandular hairs or in specialized tubes. A variety of plant parts such as leaves of lemongrass, bark of cinnamon, flower buds of clove, nutmeg seeds and camphorwood contains volatile oils. The phenolic compound are soluble in water and includes phenols, phenolic acids, phenyl propanoids, coumarins, phenyl propenes, flavonoid pigments, anthocyanins, flavonols, flavones and tannins

Due to the presence of bioactive molecules plants are used as phytomedicine to cure many complaints. Catharanthus roseus has 'vinblastine' and 'vincristine' and used in cancer. Rauwolfia serpentina is hypotensive due to presence of 'serpentine', 'reserpine' and 'ajmalicine'. Papaver somniferum contains 'morphine' and 'codeine' and is analgesic and sedative. 'Artemisinin' is effective against malaria derived from A. annua. Similarly, the bioactive components of plants 'Withanaloides' reported from Withania somnifera useful in treatment of arthritis. 'Charantin' a steroidal saponin, isolated from Momordica charantia reported for anti-diabetic activity. 'Diospyrin' reported from Diosyros species acts as antileishmanial agent. 'Tephdidoside' is a flavanol glycoside derived from Tephorsea candida found to be active against human cancer [16]. 'Berberine' derived from Berberis vulgaris reported for antidiabetic, hepatoprotective, antimicrobial activity. 'Digoxin'obtained from Digitalis lanata used in heart diseases. Similarly, 'Quinine' isolated from Cinchona robusta acts as antimalerial, antiparasitic agent. Another compound

'Allicin' isolated from A. sativum reported for its cardioprotective, anti-inflammatory activity [17].

More than 35,000 plant species have been investigated and resulted in the discovery of anticancer drugs such as 'Vincristine', 'Vinblastine', 'Taxol', 'Etoposide analogs', 'Camptothecin' etc. Many number of effective drugs derived from higher plants were alkaloid 'Paclitaxol', isolated from Taxus brevifolia used in treatment of ovarian and breast cancers [18]. 'Andrographolide', active diterpine derived from A. paniculata acts as a noble anticancer agent against cancers of breast, ovary, stomach, colon, prostate, kidney, nasopharynx malignant melanoma and leukemia. 'Thymoquinone' and 'dithymoquinone' of Nigella sativa shows anticancer activity against different types of cancers such as colon, prostate, pancreas, uterus, malignant ascites, malignant lymphoma, malignant melanoma, sarcomas and leukemia. However, 'Plumbagin' isolated from Plumbago zeylanica hinders growth and spread of breast cancer, liver cancer, fibro-sarcoma, malignant ascites and leukemia by cell proliferation [19].

A wide range of reports are available on phytochemicals and pharmacological activity of medicinal plants. Several workers have reported biological activity of medicinal plants. Pharmacognostic and preliminary phytochemical analysis of Colocasia esculenta dried tubers were calculated. The tubers are good source of carbohydrate, protein and starch. Nutritional analysis showed moisture content (56.8%), ash content (1.22%), carbohydrate (3000 mg/100gm), protein (824 mg/100gm) and starch (2700 mg/100gm) in dry tubers. Phytochemical analysis revealed the presence of alkaloids, glycosides, flavonoids, terpenoids, saponins and phenols [20]. A. aspera important medicinal plants reported in Ayurvedic literature with number of medicinal property. Phytochemical investigation of plant extracts were subjected to qualitative screening test for various constituents. This revealed the presence protein, glycosides, alkaloids, tannins and phenolic compound, steroid reducing sugars and saponin glycosides [21]. Pharmacognostic and phytochemical evaluation of Tridax procumbens were studied. The quantitative microscopical and histological study is done revealed the presence of Tricomes, palisade tissue, trachieds and vessels in powder microscopy. Phytochemical analysis of the whole plant is done and the presence of carbohydrates, sterioids, phenols and tannins were reported and quercitin is confirmed using HPTLC [22].

In parallel, phytochemical screening of Cinnamomum zeylanicum shows the presence of carbohydrate, glycoside, protein, tannins, saponins, flavonoids and terpenoids. The proximate analysis revealed that water soluble extractive values of leaves was 29.75, total ash value was 9.75, acid insoluble ash was found to be 2.50 and sulphated ash was 37.35. Anti- microbial activity of the disk diffusion method showed that chloroform and hydro-ethanol extracts of leaf were more effective against Gram–positive bacteria in vitro [23].

Antimicrobial activity of different extract of Cynodon dactylon was tested against disease causing bacterial pathogens using the agar well diffusion method. Areal parts of ethanol extract show more activity against Pseudomonas aeruginosa and Staphylococcus aureus with zone of inhibition 13.83 ± 0.29 mm and 2.0 ± 0.10 mm respectively. A total 20 compounds were identified from the hydroalcoholic extract of the whole parts through GC–MS analysis. Among all, hexadecanoic acid, ethyl ester inolenic acid, ethyl ester was the major components of the hydroalcoholic extract and hexadecanoic acid ethyl ester was abundant. The antioxidant activity of the hydro-alcoholic extract of aerial parts was studied in vitro by different methods. Of this superoxide radical scavenging assay revealed a maximum inhibition of 93.33%. Total antioxidant capacity equivalent of ascorbic acid was 172.39 mg/g of extract. Similaly, anticancer activity of methanolic extracts of leaves was studied in ascitic lymphoma (ELA) in Swiss albino mice. Results demonstrate that methanolic extract was found to be antiproliferative at lower concentrations and induced apoptotic cell death in COLO 320 DM cells [24].

Pothos scandens another medicinally important plant screened for its various biological activity. At lower concentration of ethanol extract was found to have more antimicrobial activity compare to other. The ethanol extract of root showed significant free radical scavenging activity with DPPH and superoxide radical scavenging activity (IC50 0.284 mg/mL and 70.84%). The active compounds of ethanol extract of aerial parts investigated through GC–MS analysis. This depicts that Dodecanoic acid, tetra decanoicacid and n-hexadecanoic acid acts as antioxidant. Similarly cytotoxicity of same plant was evaluated against MCF-7 (breast cancer) cell lines by MTT assay and results revealed that the extract has significant cytotoxic activity with an IC50 of 90.18 ± 5.20 µg/ml and also cell death of MCF-7 treated with the extract was due to the induction of apoptosis, which was confirmed by comet assay [25].

The in vitro cytotoxic activity of Colocasia gigantea extract on cervical cancer (Hela) and human white blood cells (WBC) was conducted. Bioassay-guided fractionation method showed that not all parts promote cytotoxic activity. The leaf fraction of dichloromethane showed significant cell proliferation effect on Hela cells, but not on WBCs. The n-hexane tuber fraction only exhibited significant cytotoxicity on Hela cells (IC50 585 µg/ml) and encouraged WBC cell proliferation. From the GC–MS spectrometry it was found the 4, 22-Stigmastadiene-3-one, Diazoprogesterone, 9-Octadecenoic acid (Z)-, hexyl ester, and Oleic Acid were the components of n- hexane tuber fraction which had cytotoxic potential. Tuber fraction of n- hexane shows potential for cervical cancer treatment[4,5,6]

DISCUSSION

Medicinal plants, also called medicinal herbs, have been discovered and used in traditional medicine practices since prehistoric times. Plants synthesize hundreds of chemical compounds for various functions, including defense and protection against insects, fungi, diseases, and herbivorous mammals.[2]

The earliest historical records of herbs are found from the Sumerian civilization, where hundreds of medicinal plants including opium are listed on clay tablets, c. 3000 BC. The Ebers Papyrus from ancient Egypt, c. 1550 BC, describes over 850 plant medicines. The Greek physician Dioscorides, who worked in the Roman army, documented over 1000 recipes for medicines using over 600 medicinal plants in De materia medica, c. 60 AD; this formed the basis of pharmacopoeias for some 1500 years. Drug research sometimes makes use of ethnobotany to search for pharmacologically active substances, and this approach has yielded hundreds of useful compounds. These include the common drugs aspirin, digoxin, quinine, and opium. The compounds found in plants

are diverse, with most in four biochemical classes: alkaloids, glycosides, polyphenols, and terpenes. Few of these are scientifically confirmed as medicines or used in conventional medicine.

Medicinal plants are widely used as folk medicine in non-industrialized societies, mainly because they are readily available and cheaper than modern medicines. The annual global export value of the thousands of types of plants with medicinal properties was estimated to be US$60 billion per year and growing at the rate of 6% per annum. In many countries, there is little regulation of traditional medicine, but the World Health Organization coordinates a network to encourage safe and rational use. The botanical herbal market has been criticized for being poorly regulated and containing placebo and pseudoscience products with no scientific research to support their medical claims.[3] Medicinal plants face both general threats, such as climate change and habitat destruction, and the specific threat of over-collection to meet market demand[7,8,9]

RESULTS

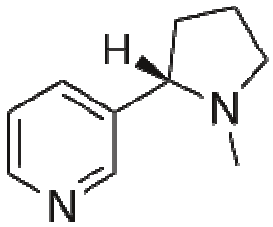
All plants produce chemical compounds which give them an evolutionary advantage, such as defending against herbivores or, in the example of salicylic acid, as a hormone in plant defenses.[44][45] These phytochemicals have potential for use as drugs, and the content and known pharmacological activity of these substances in medicinal plants is the scientific basis for their use in modern medicine, if scientifically confirmed.[3] For instance, daffodils (Narcissus) contain nine groups of alkaloids including galantamine, licensed for use against Alzheimer's disease. The alkaloids are bitter-tasting and toxic, and concentrated in the parts of the plant such as the stem most likely to be eaten by herbivores; they may also protect against parasites.[46][47][48]

Modern knowledge of medicinal plants is being systematised in the Medicinal Plant Transcriptomics Database, which by 2011 provided a sequence reference for the transcriptome of some thirty species.[49] Major classes of plant phytochemicals are described below, with examples of plants that contain them.[8][43][50][51][52]

Alkaloids

Alkaloids are bitter-tasting chemicals, very widespread in nature, and often toxic, found in many medicinal plants.[53] There are several classes with different modes of action as drugs, both recreational and pharmaceutical. Medicines of different classes include atropine, scopolamine, and hyoscyamine (all from nightshade),[54] the traditional medicine berberine (from plants such as Berberis and Mahonia),[b] caffeine (Coffea), cocaine (Coca), ephedrine (Ephedra), morphine (opium poppy), nicotine (tobacco),[c] reserpine (Rauvolfia serpentina), quinidine and quinine (Cinchona), vincamine (Vinca minor), and vincristine (Catharanthus roseus).[52][57]

The opium poppy Papaver somniferum is the source of the alkaloids morphine and codeine.[52]



The alkaloid nicotine from tobacco binds directly to the body's Nicotinic acetylcholine receptors, accounting for its pharmacological effects.[58]

Deadly nightshade, Atropa belladonna, yields tropane alkaloids including atropine, scopolamine and hyoscyamine.[54]

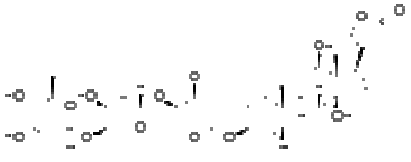
Glycosides

Anthraquinone glycosides are found in medicinal plants such as rhubarb, cascara, and Alexandrian senna.[59][60] Plant-based laxatives made from such plants include senna,[61] rhubarb[62] and Aloe.[52]

The cardiac glycosides are powerful drugs from medicinal plants including foxglove and lily of the valley. They include digoxin and digitoxin which support the beating of the heart, and act as diuretics.[44]

Senna alexandrina, containing anthraquinone glycosides, has been used as a laxative for millennia.[61]

The foxglove, Digitalis purpurea, contains digoxin, a cardiac glycoside. The plant was used on heart conditions long before the glycoside was identified.[44][63]



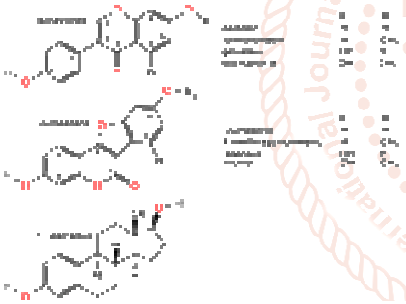
Digoxin is used to treat atrial fibrillation, atrial flutter and sometimes heart failure.[44]

Polyphenols

Polyphenols of several classes are widespread in plants, having diverse roles in defenses against plant diseases and predators.[44] They include hormone-mimicking phytoestrogens and astringent tannins.[52][64] Plants containing phytoestrogens have been administered for centuries for gynecological disorders, such as fertility, menstrual, and menopausal problems.[65] Among these plants are Pueraria mirifica,[66] kudzu,[67] angelica,[68] fennel, and anise.[69]

Many polyphenolic extracts, such as from grape seeds, olives or maritime pine bark, are sold as dietary supplements and cosmetics without proof or legal health claims for medicinal effects.[70] In Ayurveda, the astringent rind of the pomegranate, containing polyphenols called punicalagins, is used as a medicine, with no scientific proof of efficacy.[70][71]

Angelica, containing phytoestrogens, has long been used for gynaecological disorders.

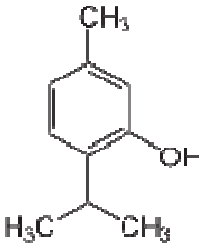


Polyphenols include phytoestrogens (top and middle), mimics of animal estrogen (bottom).[72]

Terpenes

Terpenes and terpenoids of many kinds are found in a variety of medicinal plants,[73] and in resinous plants such as the conifers. They are strongly aromatic and serve to repel herbivores. Their scent makes them useful in essential oils, whether for perfumes such as rose and lavender, or for aromatherapy.[52][74][75] Some have medicinal uses: for example, thymol is an antiseptic and was once used as a vermifuge (anti-worm medicine).[76]

The essential oil of common thyme (Thymus vulgaris), contains the monoterpene thymol, an antiseptic and antifungal.[76]



Thymol is one of many terpenes found in plants.[76]

In practice Licensed commercial cultivation of opium poppies, Tasmania, 2010

Cultivation

Medicinal plants demand intensive management. Different species each require their own distinct conditions of cultivation. The World Health Organization recommends the use of rotation to minimise problems with pests and plant diseases. Cultivation may be traditional or may make use of conservation agriculture practices to maintain organic matter in the soil and to conserve water, for example with no-till farming systems.[77] In many medicinal and aromatic plants, plant characteristics vary widely with soil type and cropping strategy, so care is required to obtain satisfactory yields.[78]

Preparation

A Medieval physician preparing an extract from a medicinal plant, from an Arabic Dioscorides, 1224

Medicinal plants are often tough and fibrous, requiring some form of preparation to make them convenient to administer. According to the Institute for Traditional Medicine, common methods for the preparation of herbal medicines include decoction, powdering, and extraction with alcohol, in each case yielding a mixture of substances. Decoction involves crushing and then boiling the plant material in water to produce a liquid extract that can be taken orally or applied topically.[79] Powdering involves drying the plant material and then crushing it to yield a powder that can be compressed into tablets.[10,11,12] Alcohol extraction involves soaking the plant material in cold wine or distilled spirit to form a tincture.[80]

Traditional poultices were made by boiling medicinal plants, wrapping them in a cloth, and applying the resulting parcel externally to the affected part of the body.[81]

When modern medicine has identified a drug in a medicinal plant, commercial quantities of the drug may either be synthesised or extracted from plant material, yielding a pure chemical.[33] Extraction can be practical when the compound in question is complex.[82]

Usage

A herbalist's shop in the souk of Marrakesh, Morocco

Further information: Herbalism, Psychoactive drug, and Drug discovery

Plant medicines are in wide use around the world.[83] In most of the developing world, especially in rural areas, local traditional medicine, including herbalism, is the only source of health care for people, while in the developed world, alternative medicine including use of dietary supplements is marketed aggressively using the claims of traditional medicine. As of 2015, most products made from medicinal plants had not been tested for their safety and efficacy, and products that were marketed in developed economies and provided in the undeveloped world by traditional healers were of uneven quality, sometimes containing dangerous contaminants.[84] Traditional Chinese medicine makes use of a wide variety of plants, among other materials and techniques.[85] Researchers from Kew Gardens found 104 species used for diabetes in Central America, of which seven had been identified in at least three separate studies.[86][87] The Yanomami of the Brazilian Amazon, assisted by researchers, have described 101 plant species used for traditional medicines.[88][89]

Drugs derived from plants including opiates, cocaine and cannabis have both medical and recreational uses. Different countries have at various times made use of illegal drugs, partly on the basis of the risks involved in taking psychoactive drugs.[90]

The bark of the cinchona tree contains the alkaloid quinine, traditionally given for malaria.

Plant medicines have often not been tested systematically, but have come into use informally over the centuries. By 2007, clinical trials had demonstrated potentially useful activity in nearly 16% of herbal extracts; there was limited in vitro or in vivo evidence for roughly half the extracts; there was only phytochemical evidence for around 20%; 0.5% were allergenic or toxic; and some 12% had basically never been studied scientifically.[43] Cancer Research UK caution that there is no reliable evidence for the effectiveness of herbal remedies for cancer.[91]

A 2012 phylogenetic study built a family tree down to genus level using 20,000 species to compare the medicinal plants of three regions, Nepal, New Zealand and the Cape of South Africa. It discovered that the species used traditionally to treat the same types of condition belonged to the same groups of plants in all three regions, giving a "strong phylogenetic signal".[92] Since many plants that yield pharmaceutical drugs belong to just these groups, and the groups were independently used in three different world regions, the results were taken to mean 1) that these plant groups do have potential for medicinal efficacy, 2) that undefined pharmacological activity is associated with use in traditional medicine, and 3) that the use of a phylogenetic groups for possible plant medicines in one region may predict their use in the other regions.[92]

Regulation

The practice of Ayurveda in India, such as the running of this Ayurvedic pharmacy in Rishikesh, is regulated by a government department, AYUSH.[13,14,15]

The World Health Organization (WHO) has been coordinating a network called the International Regulatory Cooperation for Herbal Medicines to try to improve the quality of medical products made from medicinal plants and the claims made for them.[93] In 2015, only around 20% of countries had well-functioning regulatory agencies, while 30% had none, and around half had limited regulatory capacity.[84] In India, where Ayurveda has been practised for centuries, herbal remedies are the responsibility of a government department, AYUSH, under the Ministry of Health & Family Welfare.[94]

WHO has set out a strategy for traditional medicines[95] with four objectives: to integrate them as policy into national healthcare systems; to provide knowledge and guidance on their safety, efficacy, and quality; to increase their availability and affordability; and to promote their rational, therapeutically sound usage.[95] WHO notes in the strategy that countries are experiencing seven challenges to such implementation, namely in developing and enforcing policy; in integration; in safety and quality, especially in assessment of products and qualification of practitioners; in controlling advertising; in research and development; in education and training; and in the sharing of information[16,17,18]

CONCLUSION

The pharmaceutical industry has roots in the apothecary shops of Europe in the 1800s, where pharmacists provided local traditional medicines to customers, which included extracts like morphine, quinine, and strychnine.[96] Therapeutically important drugs like camptothecin (from Camptotheca acuminata, used in traditional Chinese medicine) and taxol (from the Pacific yew, Taxus brevifolia) were derived from medicinal plants.[97][33] The Vinca alkaloids vincristine and vinblastine, used as anti-cancer drugs, were discovered in the 1950s from the Madagascar periwinkle, Catharanthus roseus.[98]

Hundreds of compounds have been identified using ethnobotany, investigating plants used by indigenous peoples for possible medical applications.[99] Some important phytochemicals, including curcumin, epigallocatechin gallate, genistein and resveratrol are pan-assay interference compounds, meaning that in vitro studies of their activity often provide unreliable data. As a result, phytochemicals have frequently proven unsuitable as the lead substances in drug discovery.[100][101] In the United States over the period 1999 to 2012, despite several hundred applications for new drug status, only two botanical drug candidates had sufficient evidence of medicinal value to be approved by the Food and Drug Administration[19,20,21]

The pharmaceutical industry has remained interested in mining traditional uses of medicinal plants in its drug discovery efforts.[33] Of the 1073 small-molecule drugs approved in the period 1981 to 2010, over half were either directly derived from or inspired by natural substances.[33][102] Among cancer treatments, of 185 small-molecule drugs approved in the period from 1981 to 2019, 65% were derived from or inspired by natural substances[22]

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